<Division of Multidisciplinary Chemistry>Polymer Materials Science

Division of Multidisciplinary Chemistry
– Polymer Materials Science –

http://www.scl.kyoto-u.ac.jp/~kanaya2/e_index.html

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Scope of Research

The structure and molecular motion of polymer substances are studied using mainly scattering methods such as neutron, X-ray and light with intension of solving fundamentally important problems in polymer science. The main projects are the mechanism of structural development in crystalline polymers from glassy or molten state to spherulites, the dynamics in disordered polymer materials including low-energy excitation, glass transition and local segmental motions; formation processes and structure of polymer gels; the structure and molecular motion of polyelectrolyte solutions.

KEYWORDS

Polymer Physics
Polymer Properties
Scattering
Neutron Scattering

Selected Publications

Asakawa, H.; Nishida, K.; Yamamoto, J.; Inoue, R.; Kanaya, T., Heating Rate Effects on the Crystallization Behavior of Isotactic Polypropylene from Mesophase–A De-polarized Light Transmission Study, *Polymer*, **53,** 2777-2782 (2012).

Polec, I.; Fujiwara, T.; Kanaya, T.; Deng, C., Simultaneous SAXS/WAXS Experiments on Shear Induced iPP Crystallization near Nominal Melting Temperature, *Polymer*, **53,** 3540-3547 (2012).

Deng, C.; Fujiwara, T.; Polec, I.; Matsuba, G.; Jin, L.; Inoue, R.; Nishida, K.; Kanaya, T., Precursor of Shish-Kebab in Atactic Polystyrene/Isotactic Polystyrene Blend above Nominal Melting Temperature, *Macromolecules*, **45,** 4360-4367 (2012).

Inoue, R.; Kanaya, T.; Masuda, T.; Nishida, K.; Yamamuro, O., Relationship between the Local Dynamics and Gas Permeability of Para-Substituted Poly(1-chloro-2-phenylacetylenes), *Macromolecules*, **45,** 6008-6014 (2012).

Kanaya, T.; Takahashi, N.; Takeshita, H.; Ohkura, M.; Nishida, K.; Kaji, K., Structure and Dynamics of Poly(vinylalchol) Gels in Mixture of Dimethyl Sulfoxide and Water, *Polymer J.*, **44,** 83-94 (2012).

Effects of Non-crystalline Atactic Polystyrene on the Shear-induced Crystallization of Isotacitic Polystyrene

We studied effects of non-crystalline high molecular weight atactic polystyrene (aPS) on the shear-induced crystallization of isotacitic polystyrene (iPS) above the nominal melting temperature T_m (=223°C) using polarized optical microscope (POM). It was found that the non-crystalline aPS accelerated the crystallization of iPS in some concentration range. An influence of aPS on the shear-induced crystallization of iPS was also examined as functions of shear rate, shear strain and concentration of aPS. It was also found that aPS enhanced the crystallization at around 4 wt % of aPS most effectively in any shear conditions (see Figure 1). These experimental findings suggest that the orientation and relaxation of non-crystalline high molecular weight aPS might have significant impact on the enhancement of crystallization under shear flow. The corresponding mechanism presents new insights into the shear-induced crystallization of polymers.

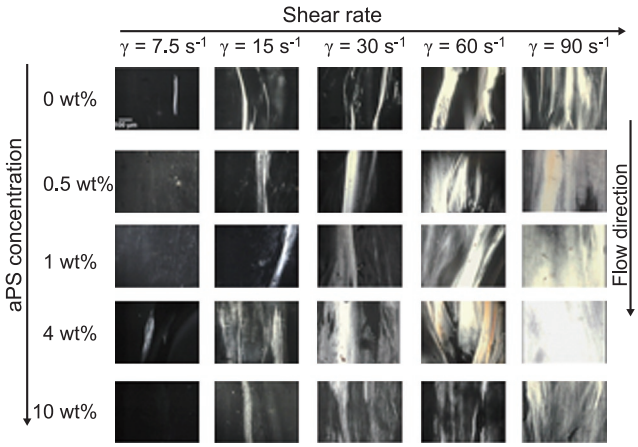

Figure 1. POM pictures of shear-induced precursors formed at different shear rates during shear flow at 250°C in iPS and aPS/iPS blends.

Relationship between the Local Dynamics and Gas Permeability of Substituted Polyacetylenes

It is well known that some polyacetylenes with bulky substituents exhibit high gas permeability among the synthetic polymers. It is considered that the physical origin of highly gas-permeable substituted polyacetylens is attributed to low apparent density due to the existence of microvoids. Recently the poly-(1-chloro-2-phenylacetylene) (PCPA) derivatives were synthesized and their gas permeability were investigated taking the advantage of excellent solubility to common organic solvents. Interestingly some PCPA derivatives exhibit high gas permeability despite of low fractional free volume (FFV), implying the existence of other controlling parameter for gas permeability other than microvoids. In order to disclose the unknown controlling parameter of gas permeability, we studied the local dynamics of PCPA derivatives by quasielastic neutron scattering (QENS). Broadening of the dynamic scattering law was clearly observed for PCPA derivatives and the observed dynamic scattering law was well fitted with the combination of slow and fast motions. Only the relaxation rate from narrow component exhibited with a positive correlation between local dynamics probed by QENS and gas permeability, as shown in Figure 2. It implies that the local dynamics with the time scale of several tens of ps play a main role for gas permeability of substituted polyacetylenes in glassy state.

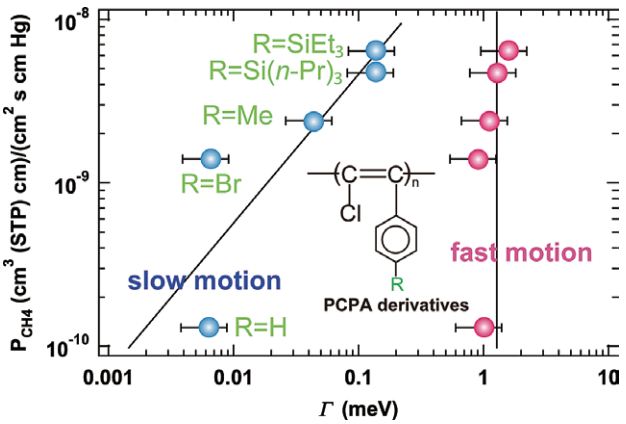

Figure 2. Correlation between P_{CH4} and the relaxation rates (Γ) for the narrow and broad components.